CLAIMS

What is claimed is:

1. An assembly for receiving and transmitting millimeter (mm) waves, comprising:

at least one mm wave reflector;

at least one mm transmission wave feed configured in a transmission feed location within the at least one mm wave reflector;

a plurality of receiving mm wave feeds configured in respective receiving feed locations within the at least one mm wave reflector; and

a radio frequency (RF) module, which is coupled to the at least one mm transmission wave feed and to the plurality of the receiving mm wave feeds, so as to drive the at least one mm transmission wave feed to transmit outgoing mm waves and to simultaneously receive incoming mm waves from all of the plurality of the receiving mm wave feeds.

2. The assembly according to claim 1, wherein the at least one mm transmission wave feed is characterized by a transmission angular-gain distribution pattern dependent upon the transmission feed location, and wherein the receiving mm wave feeds are characterized by respective reception angular-gain distribution patterns dependent upon the respective receiving feed locations, so that the reception angular-gain distribution patterns form an overall reception angular-gain distribution pattern which is substantially similar to the transmission angular-gain distribution pattern.

3. The assembly according to claim 2, and comprising a radome which is adapted to cover the at least one mm wave reflector and to interact with the outgoing mm waves so as to form the transmission angular-gain distribution pattern, and to interact with the incoming waves so as to form the overall transmission angular-gain distribution pattern

4. The assembly according to claim 1, wherein the at least one mm wave reflector, the at least one mm transmission wave feed, the plurality of receiving mm wave feeds, and the RF module, are adapted to be mounted as a unit on an automotive vehicle.

5. The assembly according to claim 1, wherein the at least one mm wave reflector, the plurality of receiving mm wave feeds, and the RF module are fixed to a

housing that is adapted to be fixed to a vehicle, and comprising a gyroscope that is coupled to the housing and that is adapted to measure a yaw rate of the vehicle.

6. An antenna system mount, comprising:

a radio frequency (RF) module which is adapted to transmit and receive millimeter (mm) waves and as a consequence generates RF-module-heat;

one or more mm wave reflectors; and

a metallic manifold comprising a plurality of waveguides therein and upon which is mounted the RF module and the mm wave reflectors, so that the plurality of waveguides convey the mm waves between the RF module and the mm wave reflectors, and so that the manifold acts as a heat sink for the RF-module-heat.

7. The mount according to claim 6, wherein the RF module comprises an RF housing having mm wave components operative therein so as to generate the RF-module-heat, and wherein the RF housing is coupled to the metallic manifold so as to transfer the RF-module-heat thereto.

8. A radome, comprising:

an insulating cover adapted to cover a mm wave transceiver and which is substantially transparent to mm waves transmitted and received by the transceiver; and

a plurality of substantially parallel conductive strips formed on the insulating cover so as to polarize the mm waves and which are coupled to receive an electric current and to heat the insulating cover in response to the current.

9. The radome according to claim 8, and comprising a unit wherein the insulating cover and the plurality of substantially parallel conductive strips formed thereon are mounted, and wherein the unit is adapted to be mounted on an automotive vehicle.

10. A transceiver, comprising:

a housing, adapted to be mounted on an automotive vehicle, the housing comprising a transmit port, which is adapted to be coupled to a transmit feed, and a multiplicity of receive ports, which are adapted to be coupled to respective receive feeds, wherein the housing is adapted to prevent passage of millimeter (mm) waves other than through the transmit and receive ports; and

a plurality of monolithic microwave integrated circuits (MMICs), which are mounted in the housing and are coupled together so as to transmit outgoing mm

waves via the transmit port and so as to receive incoming mm waves in a multiplicity of mm wave channels via the receive ports.

11. The transceiver according to claim 10, wherein the plurality of MMICs comprise one or more mixers which receive the incoming waves and a portion of the outgoing mm waves and in response generate baseband signals, and wherein the housing comprises a connector which transfers the baseband signals outside the housing while preventing passage of mm waves.

12. A forward-looking radar system, comprising:

a millimeter (mm) wave transceiver, which is adapted to transmit mm waves toward a target and to receive the mm waves reflected from the target so as to provide signals in response to the reflected waves, the transceiver having a first state in which the transceiver transmits and receives the mm waves in accordance with a Range-Doppler process, and a second state in which the transceiver transmits and receives the mm waves in accordance with a linear frequency modulated continuous wave (LFMCW) process; and

a processing module, which is coupled to process the signals so as to determine a position and a velocity of the target, and which is adapted, in response to the position and the velocity, to switch the transceiver between the first state and the second state.

13. The system according to claim 12, and comprising a unit wherein the mm wave transceiver and the processing module are mounted, wherein the unit is adapted to be mounted on an automotive vehicle, and wherein the target comprises an automotive target.

14. The system according to claim 13, wherein the Range-Doppler process comprises:

transmitting a first train of mm wave single-slope chirps from the automotive vehicle, the first train having a first pulse repetition interval (PRI);

receiving first mm reflected waves from the automotive target at the automotive vehicle in response to the first train;

generating first signals in response to the first mm reflected waves;

determining from the first signals a first plurality of possible velocities of the automotive target;

transmitting a second train of mm wave single-slope chirps from the automotive vehicle, the second train having a second PRI different from the first PRI;

receiving second mm reflected waves from the automotive target at the automotive vehicle in response to the second train;

generating second signals in response to the second mm reflected waves;

determining from the second signals a second plurality of possible velocities of the automotive target; and

correlating the first and second pluralities of possible velocities to determine a true velocity of the automotive target.

15. The system according to claim 13, wherein the Range-Doppler process comprises:

transmitting a train of mm wave single-slop chirps having multiple frequencies from the automotive vehicle;

receiving reflected mm waves from the automotive targets in response to the chirp;

mixing the reflected mm waves with the frequencies of the chirps in order to determine beat frequencies;

performing a plurality of Fast Fourier Transforms (FFT) sequentially on the beat frequencies to determine transformed values; and

determining the position and the velocity of the automotive target in response to the transformed values.

16. The system according to claim 13, wherein the automotive target comprises a first and a second automotive target, and wherein the LFMCW process comprises:

transmitting toward the automotive targets a sequence of mm wave positive single-slope chirps, each of the chirps comprising multiple frequencies;

receiving reflected mm waves from the automotive targets in response to the chirps;

mixing the reflected mm waves with the frequencies of the chirps in order to determine beat frequencies; and

determining a position and a velocity of the first automotive target and a position and a velocity of the second automotive target in response to the beat frequencies.

17. The system according to claim 16, wherein determining the position and

velocity of the first and second automotive targets comprises maintaining a track file comprising the positions of the first and second automotive targets and determining the velocities of the first and second automotive targets by evaluating differences of the positions.

18. The system according to claim 17, wherein maintaining the track file comprises evaluating initial positions of the first and second automotive targets after an initial chirp comprised in the sequence of chirps, and evaluating subsequent positions of the first and second automotive targets after a subsequent chirp comprised in the sequence of chirps, and wherein determining the velocities comprises evaluating differences between the subsequent and the initial positions, and comparing the differences to a time between the initial and the subsequent chirp.

19. A method for tracking a first and a second target, comprising:

transmitting toward the targets a sequence of millimeter (mm) wave chirps, each of the chirps comprising multiple frequencies and having substantially identical positive single-slopes;

receiving reflected mm waves from the targets in response to the chirps;

mixing the reflected mm waves with the frequencies of the chirps in order to determine beat frequencies; and

determining a position and a velocity of the first target and a position and a velocity of the second target in response to the beat frequencies.

20. The method according to claim 19, wherein transmitting the sequence of mm wave chirps comprises transmitting an initial chirp and a subsequent chirp, and wherein determining the position and the velocity of the first target and of the second target comprises determining an initial position of the first target and an initial position of the second target in response to the initial chirp, and determining a subsequent position of the first target and a subsequent position of the second target in response to the subsequent chirp, and determining the velocity of the first target in response to the initial position and subsequent position of the first target and the velocity of the second target in response to the initial position and subsequent position of the second target.

21. The method according to claim 19, wherein determining the position and the velocity of the first target comprises maintaining a track file comprising a previous

position and a previous velocity of the first target, and finding a predicted position and a predicted velocity of the first target in response to the previous position and the previous velocity, and comparing the predicted position and the predicted velocity with a resultant position and a resultant velocity of the first target determined from the beat frequencies.

22. A method for producing a reflector for a millimeter (mm) wave antenna, comprising:

molding the reflector at a molding temperature sufficiently close to an operating temperature of the reflector so that changes of dimensions of the reflector due to a change from the production temperature to the operating temperature cause no substantial change in action of the reflector on the mm waves.

23. The method according to claim 22, wherein molding the reflector comprises molding the reflector using thixo-molded magnesium.

24. The method according to claim 22, wherein the reflector comprises a plurality of reflecting apertures, and wherein molding the reflector comprises molding the plurality of reflecting apertures as a single metallic block.

25. A method for receiving and transmitting millimeter (mm) waves, comprising:

providing at least one mm wave reflector;

determining a transmission feed location within the at least one mm wave reflector;

configuring at least one mm transmission wave feed in the transmission feed location;

determining a plurality of receiving feed locations within the at least one mm wave reflector;

configuring respective receiving mm wave feeds in the plurality of receiving feed locations; and

coupling a radio frequency (RF) module to the at least one mm transmission wave feed and to the plurality of the receiving mm wave feeds, so as to drive the at least one mm transmission wave feed to transmit outgoing mm waves and to simultaneously receive incoming mm waves from all of the plurality of the receiving mm wave feeds.

26. The method according to claim 25, wherein the at least one mm transmission

wave feed is characterized by a transmission angular-gain distribution pattern dependent upon the transmission feed location, and wherein the receiving mm wave feeds are characterized by respective reception angular-gain distribution patterns dependent upon the respective receiving feed locations, so that the reception angular-gain distribution patterns form an overall reception angular-gain distribution pattern which is substantially similar to the transmission angular-gain distribution pattern.

27. The method according to claim 26, and comprising covering the at least one mm wave reflector with a radome which is adapted to interact with the outgoing mm waves so as to form the transmission angular-gain distribution pattern, and to interact with the incoming waves so as to form the overall transmission angular-gain distribution pattern

28. The method according to claim 25, wherein the at least one mm wave reflector, the at least one mm transmission wave feed, the plurality of receiving mm wave feeds, and the RF module, are adapted to be mounted as a unit on an automotive vehicle.

29. The method according to claim 25, wherein the at least one mm wave reflector, the plurality of receiving mm wave feeds, and the RF module are fixed to a housing that is adapted to be fixed to a vehicle, and comprising coupling a gyroscope that is adapted to measure a yaw rate of the vehicle to the housing.

30. A method for mounting an antenna system, comprising:

transmitting and receiving in a radio frequency (RF) module millimeter (mm) waves and as a consequence generating RF-module-heat;

providing one or more mm wave reflectors; and

mounting the RF module and the mm wave reflectors on a metallic manifold comprising a plurality of waveguides therein, so that the plurality of waveguides convey the mm waves between the RF module and the mm wave reflectors, and so that the manifold acts as a heat sink for the RF-module-heat.

31. The method according to claim 30, wherein the RF module comprises an RF housing having mm wave components operative therein so as to generate the RF-module-heat, and wherein the RF housing is coupled to the metallic manifold so as to transfer the RF-module-heat thereto.

32. A method for forming a radome, comprising:

covering a mm wave transceiver with an insulating cover which is substantially transparent to mm waves transmitted and received by the transceiver; and

forming on the insulating cover a plurality of substantially parallel conductive strips which are adapted to polarize the mm waves and which are coupled to receive an electric current and to heat the insulating cover in response to the current.

33. The method according to claim 32, and comprising providing a unit wherein the insulating cover and the plurality of substantially parallel conductive strips formed thereon are mounted, and wherein the unit is adapted to be mounted on an automotive vehicle.

34. A method for transmitting and receiving millimeter (mm) waves, comprising:

mounting a housing on an automotive vehicle, the housing comprising a transmit port, which is adapted to be coupled to a transmit feed, and a multiplicity of receive ports, which are adapted to be coupled to respective receive feeds, wherein the housing is adapted to prevent passage of the mm waves other than through the transmit and receive ports; and

mounting within the housing a plurality of monolithic microwave integrated circuits (MMICs), which are coupled together so as to transmit outgoing mm waves via the transmit port and so as to receive incoming mm waves in a multiplicity of mm wave channels via the receive ports.

35. The method according to claim 34, wherein the plurality of MMICs comprise one or more mixers which receive the incoming waves and a portion of the outgoing mm waves and in response generate baseband signals, and wherein the housing comprises a connector which transfers the baseband signals outside the housing while preventing passage of mm waves.

36. A method for operating a forward-looking radar unit, comprising:

providing a millimeter (mm) wave transceiver, which is adapted to transmit mm waves toward a target and to receive the mm waves reflected from the target so as to provide signals in response to the reflected waves, the transceiver having a first state in which the transceiver transmits and receives the mm waves in accordance with a Range-Doppler process, and a second state in which the transceiver transmits and receives the mm waves in accordance with a linear frequency modulated

continuous wave (LFMCW) process; and

coupling a processing module to the transceiver to process the signals so as to determine a position and a velocity of the target, the processing module being adapted, in response to the position and the velocity, to switch the transceiver between the first state and the second state.

37. The method according to claim 36, and comprising a mounting the mm wave transceiver and the processing module within a unit that is adapted to be mounted on an automotive vehicle, and wherein the target comprises an automotive target.

38. The system according to claim 37, wherein the Range-Doppler process comprises:

transmitting a first train of mm wave single-slope chirps from the automotive vehicle, the first train having a first pulse repetition interval (PRI);

receiving first mm reflected waves from the automotive target at the automotive vehicle in response to the first train;

generating first signals in response to the first mm reflected waves;

determining from the first signals a first plurality of possible velocities of the automotive target;

transmitting a second train of mm wave single-slope chirps from the automotive vehicle, the second train having a second PRI different from the first PRI;

receiving second mm reflected waves from the automotive target at the automotive vehicle in response to the second train;

generating second signals in response to the second mm reflected waves;

determining from the second signals a second plurality of possible velocities of the automotive target; and

correlating the first and second pluralities of possible velocities to determine a true velocity of the automotive target.

39. The system according to claim 37, wherein the Range-Doppler process comprises:

transmitting a train of mm wave single-slop chirps having multiple frequencies from the automotive vehicle;

receiving reflected mm waves from the automotive targets in response to the chirp;

mixing the reflected mm waves with the frequencies of the chirps in order to

determine beat frequencies;

performing a plurality of Fast Fourier Transforms (FFT) sequentially on the beat frequencies to determine transformed values; and

determining the position and the velocity of the automotive target in response to the transformed values.

40. The system according to claim 37, wherein the automotive target comprises a first and a second automotive target, and wherein the LFMCW process comprises:

transmitting toward the automotive targets a sequence of mm wave positive single-slope chirps, each of the chirps comprising multiple frequencies;

receiving reflected mm waves from the automotive targets in response to the chirps;

mixing the reflected mm waves with the frequencies of the chirps in order to determine beat frequencies; and

determining a position and a velocity of the first automotive target and a position and a velocity of the second automotive target in response to the beat frequencies.

41. The method according to claim 40, wherein determining the position and velocity of the first and second automotive targets comprises maintaining a track file comprising the positions of the first and second automotive targets and determining the velocities of the first and second automotive targets by evaluating differences of the positions.

42. The method according to claim 41, wherein maintaining the track file comprises evaluating initial positions of the first and second automotive targets after an initial chirp comprised in the sequence of chirps, and evaluating subsequent positions of the first and second automotive targets after a subsequent chirp comprised in the sequence of chirps, and wherein determining the velocities comprises evaluating differences between the subsequent and the initial positions, and comparing the differences to a time between the initial and the subsequent chirp.

43. Apparatus for tracking a first and a second target, comprising:

an antenna assembly which is adapted to transmit toward the targets a sequence of millimeter (mm) wave chirps, each of the chirps comprising multiple frequencies and having substantially identical positive single-slopes, and to receive

reflected mm waves from the targets in response to the chirps;

a radio frequency (RF) module which is adapted to mix the reflected mm waves with the frequencies of the chirps in order to determine beat frequencies; and

a digital signal processor which is adapted to determine a position and a velocity of the first target and a position and a velocity of the second target in response to the beat frequencies.

44. The apparatus according to claim 43, wherein transmitting the sequence of mm wave chirps comprises transmitting an initial chirp and a subsequent chirp, and wherein determining the position and the velocity of the first target and of the second target comprises determining an initial position of the first target and an initial position of the second target in response to the initial chirp, and determining a subsequent position of the first target and a subsequent position of the second target in response to the subsequent chirp, and determining the velocity of the first target in response to the initial position and subsequent position of the first target and the velocity of the second target in response to the initial position and subsequent position of the second target.

45. The method according to claim 43, wherein determining the position and the velocity of the first target comprises maintaining a track file comprising a previous position and a previous velocity of the first target, and finding a predicted position and a predicted velocity of the first target in response to the previous position and the previous velocity, and comparing the predicted position and the predicted velocity with a resultant position and a resultant velocity of the first target determined from the beat frequencies.

46. A millimeter (mm) wave antenna sub-assembly, comprising:

a reflector that is molded at a molding temperature sufficiently close to an operating temperature of the reflector so that changes of dimensions of the reflector due to a change from the production temperature to the operating temperature cause no substantial change in action of the reflector on the mm waves.

47. The sub-assembly according to claim 46, wherein the reflector comprises thixo-molded magnesium.

48. The sub-assembly according to claim 46, wherein the reflector comprises a plurality of reflecting apertures, and wherein molding the reflector comprises a single

metallic block.